

# IGS DIRECTORY



IGS Central Bureau

Jet Propulsion Laboratory, MS 238-540

4800 Oak Grove Drive, Pasadena, CA 91109-8099 U.S.A.

INTERNATIONAL GPS SERVICE  
FOR GEODYNAMICS



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# IGS 1998 DIRECTORY INFORMATION UPDATE FORM

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Type or print changes **CLEARLY**

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**PLEASE KEEP ME IN THE IGS DIRECTORY FOR 1998**

☐ Yes!

☐ No!

☐ Add new listing

☐ Update existing information (*list changes only*)

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Home Phone: \_\_\_\_\_ (*optional*)

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## IGS DIRECTORY

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# IGS INFORMATION





# INTERNATIONAL GPS SERVICE FOR GEODYNAMICS (IGS)

The IGS, a service established by the International Association of Geodesy (IAG), officially started its activities on January 1, 1994 after a successful pilot phase of more than one year.

IGS is based on about 140 globally distributed permanent GPS tracking sites, three Global Data Centers, five Operational or Regional Data Centers, seven Analysis Centers, an Analysis Center Coordinator, and a Central Bureau.

Over 60 institutions and organizations contribute to these activities.

The IGS routinely provides:

- High-quality orbits for all GPS satellites (estimated accuracy better than 20 cm)
- Earth Rotation Parameters
- Contributions to the determination of the tracking site coordinates in the International Terrestrial Reference Frame (ITRF), in cooperation with the International Earth Rotation Service (IERS)
- Phase and pseudorange observations in daily RINEX files for each IGS tracking site

The tracking data are available at various Data Centers, the individual orbits determined by the Analysis Centers at the Global Data Centers and the combined official IGS orbits at the Central Bureau and the Global Data Centers (see below). The combined official IGS orbits are produced by the Analysis Center Coordinator located at the Geodetic Division of the Natural Resources of Canada, in Ottawa, Canada.

The Central Bureau, located at the Jet Propulsion Laboratory in Pasadena, California, U.S.A. maintains an IGS Information System (CBIS) accessible at:

- <http://igscb.jpl.nasa.gov> (World Wide Web)
- <ftp://igscb.jpl.nasa.gov/igscb> (anonymous FTP)

The CBIS contains:

- Information about
  - the availability of tracking data and IGS products
  - the access to tracking data and IGS products
  - data file formats
  - the IGS data and analysis centers
  - the IGS tracking stations
  - the current status of the Global Positioning System
- IGS orbits, IERS earth rotation parameters
- Mail and e-mail addresses
- Access software, compress/decompress routines
- IGSMail and IGSREPORT messages exchanged within the IGS community

Please direct questions to the Central Bureau:

- E-Mail: [igscb@igscb.jpl.nasa.gov](mailto:igscb@igscb.jpl.nasa.gov)
- Fax (818) 393-6686
- Tel (818) 354-8330

Gerhard Beutler, Chairman

Ruth Neilan, Central Bureau



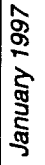
# CONTRIBUTING AGENCIES

## International GPS Service for Geodynamics

AIUB	Astronomical Institute, University of Bern, Switzerland
ALO	Astronomical Latitude Observatory, Poland
ASI	Italian Space Agency, Matera, Italy
AUSLIG	Australian Survey and Land Information Group, Australia
BfL	Bundesamt für Landestopographie (Federal Topography), Switzerland
CAS	Chinese Academy of Sciences, China
CDDIS	Crustal Dynamics Data Information System, USA
CEE	Centro de Estudios Espaciales, Chile
CMMACS	CSIR Centre for Mathematical Modeling and Computer Simulation, Bangalore, India
CNES	Centre National de Etudes, Toulouse, France
CSR	Center for Space Research, University of Texas at Austin, USA
CU	University of Colorado at Boulder, Boulder, CO, USA
DMA	Defense Mapping Agency, USA
DOSLI	Department of Survey and Land Information, Wellington, New Zealand
DUT	Delft University of Technology, Netherlands
ERI	Earthquake Research Institute, University of Tokyo, Japan
ESA	European Space Agency, Germany
ESOC	European Space Operations Center, Germany
FGI	Finnish Geodetic Institute, Finland
FOMI	FOMI Satellite Geodetic Observatory, Budapest, Hungary
GOPE	Geodetic Observatory Pecny, Ondrejov, Czech Republic
GFZ	GeoforschungsZentrum Institute, Potsdam, Germany
GIUA	Geophysical Institute, University of Alaska, Fairbanks, AK, USA
GRDL	Geosciences Research and Development Laboratory, NOAA, Silver Spring, MD, USA
GSC	Geological Survey of Canada, NRCan, Canada
GSD	Geodetic Survey Division, NRCan, Canada
GSFC	Goddard Space Flight Center, USA
GSI	Geographical Survey Institute, Tsukuba, Japan
IAA	Institute of Applied Astronomy, St. Petersburg, Russia
IBGE	Instituto Brasileiro de Geografia e Estatística, Brazil
ICC	Institut Cartografic de Catalunya, Barcelona, Spain
IDA	International Deployment of Accelerometers / IRIS, Scripps Institution of Oceanography, USA
IESAS	Academia Sinica, Institute of Earth Sciences, Taiwan
IfAG	Institut für Angewandte Geodäsie, Frankfurt, Germany
IGN	Institut Geographique National, Paris, France
IGNS	Institute of Geological and Nuclear Sciences, New Zealand
IMVP	The Institute of Metrology for Time and Space, GP VNIIFTRI, Mendeleevo, Russia
INASAN	Institute of Astronomy, Russian Academy of Sciences, Moscow, Russia
INPE	Instituto Nacional de Pesquisas Espaciais, Brazil
IRIS	Incorporated Research Institutions for Seismology, USA
ISAS	Institute for Space and Astronautic Science, Sagami-hara, Japan
ISRO	Institute for Space Research Observatory, Graz, Austria
JPL	Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA
KAO	Korean Astronomy Observatory, Taejeon, Korea
NASA	National Aeronautics and Space Administration, USA
NBSM	National Bureau of Surveying and Mapping, China
NGRI	National Geophysical Research Institute, Hyderabad, India
NOAA	National Oceanic and Atmospheric Administration, USA
NRCan	Natural Resources of Canada (formerly EMR), Ottawa, Canada
OSO	Onsala Space Observatory, Sweden
OUAT	Olsztyn University of Agriculture and Technology, Poland
PGGA	Permanent GPS Geodetic Array of Southern California, USA
POL	Proudman Oceanographic Laboratory, UK
RGO	Royal Greenwich Observatory, UK
ROA	Real Instituto y Observatorio de la Armada, Spain
ROB	Observatoire Royal de Belgique, Brussels, Belgium
SAO	Shanghai Astronomical Observatory, China
SIO	Scripps Institution of Oceanography, San Diego, CA, USA
SK	Statens Kartverk, Norwegian Mapping Authority, Norway
UB	University of Bonn, Germany
UFPR	University Federal de Parana, Brazil
UNAVCO	University Navstar Consortium, Boulder, CO, USA
UNT	University of Newcastle-on-Tyne, United Kingdom
UPAD	University of Padova, Italy
USNO	United States Naval Observatory, USA
WING	Western Pacific Integrated Network of GPS, Japan
WTU	Wuhan Technical University, China
WUT	Warsaw University of Technology, Poland

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## GLOBAL STATIONS<sup>†</sup>



† Analyzed by at least three IGS Analysis Centers, at least one of which is on a different continent

# GPS TRACKING NETWORK—LISTING

## International GPS Service for Geodynamics

id	City	Location	lon (E)	lat (N)	Agency	id	City	Location	lon (E)	lat (N)	Agency
1 • albh	Victoria, British Columbia	Canada	-123.4870	48.3888	NRCan-GSC	51 • hers	Halisham	United Kingdom	0.3363	50.8673	RGO
2 • alpo	Algonquin Park, Ontario	Canada	-78.0714	45.9558	NRCan-GSD	52 • hrlk	Innsbruck	Austria	11.3861	47.3129	ISR
3 • ankr	Ankara	Turkey	32.7585	39.8874	IIAG	53 • hnpd	Cambridge, MD	USA	-76.0400	38.3300	NOAA
4 • aosa	Westlake, CA	USA	-118.8300	34.1574	JPL	54 • hoba	Hobart, Tasmania	Australia	147.4387	-42.8047	AUSLIG
5 • areq	Arequipa	Peru	-71.4928	-16.4655	JPL	55 • hohc	Pearblossom, CA	USA	-117.8450	34.4582	USGS-SIO
6 • asc1	Ascension Island	Ascension Island	-14.4121	-7.9512	JPL	56 • hiao	Krugersdorp	South Africa	27.6872	-25.8898	JPL
7 • auck	Auckland	New Zealand	174.8344	-36.6028	JPL	57 • ilsc	Bangalore	India	77.5704	13.0212	JPL
8 • azu1	Azusa, CA	USA	-117.8960	34.1260	JPL	58 • irkt	Irkutsk	Russia	104.3162	52.2190	DUT
9 • bah1	Manama	Bahrain	-50.6081	26.2091	DMA	59 • joze	Jozefoslaw	Poland	21.0315	52.0973	IGGA-WUT
10 • blyt	Blythe, CA	USA	-114.7150	33.6104	SIO	60 • jplm	Pasadena, CA	USA	-118.1730	34.2048	JPL
11 • bog1	Bogota	Colombia	-74.0809	4.6401	JPL	61 • kely	Kangerlussuaq	Greenland	-50.9448	66.9674	NOAA
12 • bor1	Borowiec	Poland	17.0735	52.2770	SRC-PAS	62 • kerg	Port aux Français	Kerguelen Islands	70.2555	-49.3515	CNES
13 • bran	Burbank, CA	USA	-118.2770	34.1849	USGS-SIO	63 • kiru	Kinua	Sweden	20.9684	67.8574	ESA
14 • braz	Brasilia	Brazil	-47.8779	-15.9475	IBGE-JPL	64 • klt3	Kitab	Uzbekistan	66.8854	39.1348	GFZ
15 • brnu	Bermuda	Bermuda Islands	-64.6963	32.3704	NOAA	65 • kokb	Kokee Park, HI	USA	-159.6650	22.1263	JPL
16 • brus	Brussels	Belgium	4.3592	50.7978	ROB	66 • kosg	Kootwijk	The Netherlands	5.8096	52.1784	DUT
17 • cagl	Cagliari	Italy	8.9728	39.1359	ASI	67 • kour	Kourou	French Guiana	-52.8060	5.2522	ESA
18 • carr	Parkfield, CA	USA	-120.4310	35.8883	JPL	68 • kwj1	Kwajalein Atoll	Kwajalein Atoll	167.7302	8.7222	JPL
19 • cas1	Casey	Antarctica	-110.5197	-66.2834	AUSLIG	69 • lams	Olstzyn	Poland	20.6699	53.8824	OUAT
20 • casa	Mammoth Lakes, CA	USA	-118.8970	37.6446	JPL	70 • lbch	Long Beach, CA	USA	-118.2030	33.7878	JPL
21 • cat1	Catalina, CA	USA	-118.4830	33.4458	JPL	71 • lhas	Lhasa	China	91.1040	29.6573	IFAG
22 • chat	Waitangi	New Zealand	-176.5660	-43.9558	JPL	72 • long	Inverdale, CA	USA	-118.0030	34.1119	USGS-SIO
23 • chil	Chilao, CA	USA	-118.0260	34.3334	USGS-SIO	73 • lggs	La Plata	Argentina	-57.9323	-34.9067	GFZ
24 • chur	Churchill, Manitoba	Canada	-94.0887	58.7591	NRCan-GSD	74 • mac1	MacQuarie Island	Australia	158.9358	-54.4995	AUSLIG
25 • cica	Ensenada	Mexico	-116.6670	31.8713	JPL	75 • mact	MacQuarie Island	Spain	-4.2497	40.4292	JPL
26 • cit1	Pasadena, CA	USA	-118.1270	34.1367	JPL	76 • mali	Malindi	Kenya	40.1944	-2.9959	ESA
27 • coco	Cocos Island	Australia	96.8340	-12.1884	AUSLIG	77 • mas1	Maspalomas	Spain	-15.6333	27.7637	ESA
28 • cose	Ridgecrest, CA	USA	-117.8090	35.9823	SIO	78 • mate	Matera	Italy	16.7045	40.6491	ASI
29 • crfp	Yucaipa, CA	USA	-117.1000	34.0391	SIO	79 • math	Lake Mathews, CA	USA	-117.4370	33.8567	SIO
30 • cro1	Christiansburg	US Virgin Islands	-64.5843	17.7569	NRAO-JPL	80 • mcom	Ross Island	Antarctica	166.6693	-77.8383	JPL
31 • csn1	Northridge, CA	USA	-118.5240	34.2535	JPL	81 • mdo1	Fort Davis, TX	USA	-104.0150	30.6805	JPL
32 • dav1	Davis	Antarctica	77.9726	-68.5773	AUSLIG	82 • mndo	Mendeleevo	Russia	37.2236	56.0275	DUT
33 • dgar	Diego Garcia	Diego Garcia	72.3702	-7.2697	JPL	83 • medi	Medicina	Italy	11.6468	44.5200	ASI
34 • dhlg	Durmid Hill, CA	USA	-115.7880	33.3898	SIO	84 • mets	Kirkkonummi	Finland	24.3953	60.2175	FGI
35 • drao	Periticon	Canada	-119.6250	49.3226	NRCan-GSC	85 • mksa	Mauna Kea	USA	-155.4560	19.8014	JPL
36 • dubo	Lac du Bonnet, Manitoba	Canada	-95.8662	50.2588	NRCan-GSC	86 • momp	Laguna Mountains, CA	USA	-116.4220	32.8919	SIO
37 • ebre	Roquefort	Spain	0.4924	40.8209	IOC	87 • nlib	North Liberty, IA	USA	-91.5749	41.7716	JPL
38 • eisl	Easter Island	Chile	-109.3630	-27.1482	JPL	88 • noto	Noto	Italy	14.9898	36.8761	ASI
39 • fair	Fairbanks, AK	USA	-147.4990	64.9780	JPL	89 • nyal	Ny Alesund	Norway	11.8651	78.9296	NMA
40 • flin	Flin Flon, Manitoba	Canada	-101.9780	54.7256	NRCan-GSC	90 • oad2	Oat Mountain, CA	USA	-118.6010	34.3299	JPL
41 • fort	Fortaleza	Brazil	-38.4256	-3.8774	NOAA	91 • ober	Oberpfaffenhofen	Germany	11.2799	48.0862	GFZ
42 • gala	Galapagos Island	Galapagos Islands	-90.3036	-0.7427	JPL	92 • ohg	O'Higgins	Antarctica	-57.9003	-63.3207	IIAG
43 • gode	Greenbelt, MD	USA	-76.8268	39.0217	NASA-GSFC	93 • onsa	Onsala	Sweden	11.9255	57.3953	OSO
44 • gold	Goldstone, CA	USA	-116.8890	35.4252	JPL	94 • pana	Papeete	Tahiti	-149.5750	-17.5667	CNES
45 • gope	Ondrejov	Czech Republic	14.7856	49.9137	RIG	95 • penc	Penc	Hungary	19.2815	47.7896	FOMI
46 • gras	Causols	France	6.9206	43.7547	CNES	96 • pert	Perth	Australia	115.8852	-31.8020	ESA
47 • graz	Graz	Austria	15.4935	47.0671	ISR	97 • pie1	Pie Town, NM	USA	-108.1190	34.3015	JPL
48 • guam	Dededo	Guam	144.8684	13.5893	JPL	98 • pin1	Pinyon Flat, CA	USA	-116.4580	33.6122	SIO
49 • hart	Pretoria	South Africa	27.7078	-25.8871	CNES	99 • pol2	Bishkek	Kyrgyzstan	74.8943	42.6798	UNAVCO
50 • harv	Harvest, CA	USA	-120.6820	34.4694	JPL	100 • pots	Potsdam	Germany	13.0661	52.3793	GFZ

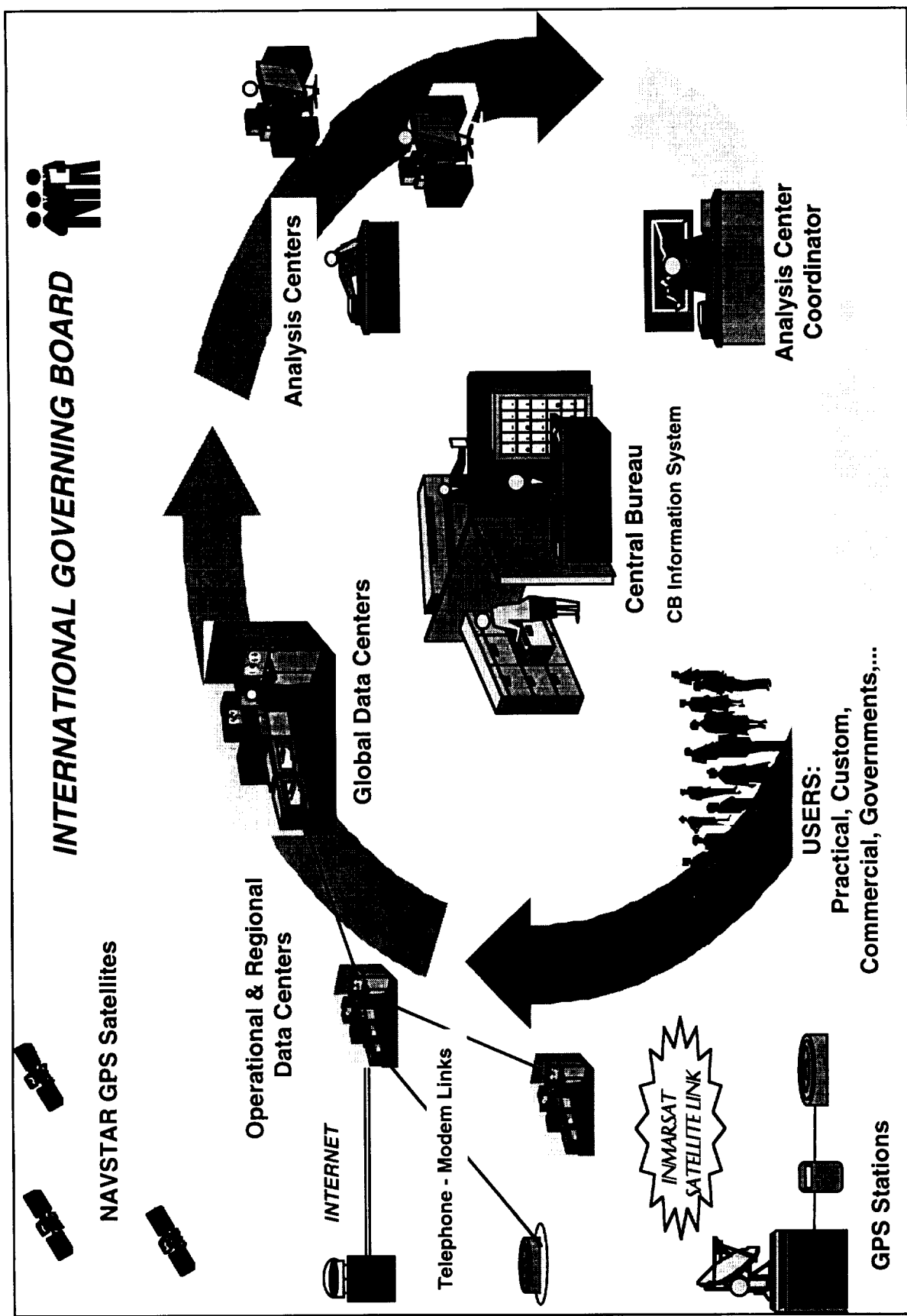
• Global Station: analyzed by at least three IGS Analysis Centers, at least one of which is on a different continent  
 \* Resolving communications and data paths  
 Locations given in decimal degrees

# GPS TRACKING NETWORK—LISTING

## International GPS Service for Geodynamics

id	City	Location	lon (E)	lat (N)	Agency	Planned or Proposed Stations
101	psep	Palos Verdes, CA	-118.4040	33.7433	SIO	Bandung Indonesia
102	quin	Quincy, CA	-120.9440	39.9746	JPL	Bar Goryora Israel
103	rom6	Perrine, FL	-80.3839	25.6138	NOAA	Changchun China
104	reyk	Reykjavik	-21.9555	64.1388	IIAG	Darwin Australia
105	sant	Santiago	-70.6886	-33.1503	JPL	Darmstadt Germany
106	sey1	Mahe Island	55.4794	-4.8737	JPL	Dudinka Russia
107	sfer	San Fernando	-6.2100	36.4600	ROA	Höfn Iceland
108	shao	Sheshan	121.2004	31.0986	JPL	Hyderabad India
109	sic3	La Jolla, CA	-117.2500	32.8647	SIO	Ishigaki Japan
110	smi1	Port Hueneme, CA	-119.5240	33.2479	JPL	Kunming China
111	sol1	Solomons Island, MD	-76.4539	38.3189	NOA/NASA	Krasnoyarsk Russia
112	spk1	Saddle Peak, CA	-118.6460	34.0593	JPL	La Paz Bolivia
113	stjo	St John's, Newfoundland	-52.6777	47.5952	NRC/Can-GSD	Libreville Gabon
114	taej	Taejon	127.3661	36.3744	KAO	Limón Costa Rica
115	taiw	Taipei	121.5365	25.0213	IES-AS	Manila Philippines
116	thu1	Thule	-68.7880	76.5373	JPL	Marcus Japan
117	tidb	Tidbinilla	148.9800	-35.3992	JPL	Mbarara Uganda
118	trak	Irvine, CA	-117.8030	33.6179	SIO	Petroavsk-Kam. Russia
119	itrom	Tromsø	18.9383	69.6627	NMA	Simeiz Ukraine
120	tskb	Tsukuba	140.0875	36.1057	GSI	Tristan da Cunha
121	uolp	Los Angeles, CA	-118.4420	34.0691	JPL	Urumqi China
122	upad	Padova	11.8779	45.4067	UP	Vladivostok Russia
123	usc1	Los Angeles, CA	-118.2850	34.0239	JPL	Wellington New Zealand
124	usna	Annapolis, MD	-76.4794	38.9633	NOA/NASA	Xi'an China
125	usud	Usuda	138.3620	36.1331	JPL	
126	vill	Villafraanca	-3.9520	40.4436	ESA	
127	vndp	Vandenberg AFB, CA	-120.6160	34.5563	SIO-JPL	
128	wes2	Westford, MA	-71.4933	42.6133	NOAA	
129	wett	Koetzing	12.8789	49.1442	IIAG	
130	whc1	Whittier, CA	-118.0310	33.9799	JPL	
131	whi1	Whittier, CA	-118.0340	33.9738	JPL	
132	whit	Whitehorse, Yukon Territory	-135.2220	60.7505	NRC/Can-GSC	
133	wisn	Mt Wilson, CA	-118.0560	34.2261	JPL	
134	wizr	Koetzing	12.8789	49.1442	IIAG	
135	wuhn	Wuhan	114.3573	30.5317	NOAA-JPL	
136	yar1	Yaregadee	115.3470	-29.0466	JPL	
137	yell	Yellowknife, NW Territories	-114.4810	62.4809	NRC/Can-GSD	
138	zimm	Zimmerwald	7.4653	46.8771	FOT	
139	zwen	Zwenigorod	36.7586	55.6993	GFZ	

# Organization of International GPS Service for Geodynamics





**GOVERNING BOARD**  
**International GPS Service for Geodynamics**

NAME	COUNTRY	FUNCTIONS	TERM
Gerhard Beutler	Switzerland	Chair, Appointed (IAG)	4 years <sup>†</sup>
Geoff Blewitt	UK	Analysis Center Representative	2 years <sup>†</sup>
Yehuda Bock	USA	Analysis Center Representative	4 years <sup>†</sup>
John Dow	Germany	Network Representative	4 years <sup>†</sup>
Bjorn Engen	Norway	Network Representative	4 years <sup>*</sup>
Claude Boucher	France	IERS Representative	---
Jan Kouba	Canada	Analysis Center Coordinator	4 years <sup>†</sup>
Gerry Mader	USA	Appointed (IGS)	2 years <sup>†</sup>
John Manning	Australia	Appointed (IGS)	4 years <sup>†</sup>
Bill Melbourne	USA	IGS Representative to IERS	---
Ivan Mueller	USA	IAG Representative	4 years <sup>†</sup>
Ruth Neilan	USA	Director of Central Bureau	---
Carey Noll	USA	Data Center Representative	4 years <sup>*</sup>
David Pugh	UK	FAGS Representative	---
Christoph Reigber	Germany	Appointed (IGS)	4 years <sup>†</sup>
Bob Schutz	USA	Appointed (IGS)	2 years <sup>†</sup>
Martine Feissel	France	former member	'94-'95
Teruyuki Kato	Japan	former member	'94-'95

\* Terms Beginning January 1, 1994

† Terms Beginning January 1, 1996

# **ASSOCIATE MEMBERS**

## **International GPS Service for Geodynamics**

Boudewijn Ambrosius  
Jeff Behr  
Loic Boloh  
Claude Boucher  
Carine Bruyninx  
Alessandro Caporali  
Miranda Chin  
Loic Daniel  
Eduardo Diaz  
Herb Dragert  
Maurice Dube  
Robert Duval  
Peng Fang  
Joachim Feltens  
Luis Paulo Fortes  
Roman Galas  
Gerd Gendt  
Werner Gurtner  
Heinz Habrich  
Martin Hendy  
Pierre Heroux  
Waldemar Jaks  
Jan Johansson  
Teruyuki Kato  
Izabella Kulhawczuk  
Ulf Lindqwister  
Chi-cheng Liu  
Thomas Martin-Mur  
C. Garcia Martinez  
Feng Meng-hua  
Matti Paunonen  
Peter Pesec  
Markus Rothacher  
Glen Rowe  
Mark Schenewerk  
Wolfgang Schlueter  
Mike Schmidt  
Andrew Sinclair  
Jim Slater  
Janusz Sledzinski  
Keith Stark  
Suryia Tatevian  
Pierre Tetreault  
Hiromichi Tsuji  
Francesco Vespe  
Mike Watkins  
Zhu Wen-yao  
Urs Wild  
Pascal Willis  
James Zumberge



## **TERMS OF REFERENCE**

### **INTERNATIONAL GPS SERVICE FOR GEODYNAMICS**

A proof of concept for the International Global Positioning System Service for Geodynamics (IGS) was conducted with a three-month campaign during June through September 1992, and was continued through a Pilot-service until the formal establishment of the IGS in 1993 by the International Association of Geodesy (IAG). The routine IGS started on 1 January, 1994. IGS is a member of the Federation of Astronomical and Geophysical Data Analysis Services (FAGS) and it operates in close cooperation with the International Earth Rotation Service (IERS).

The primary objective of the IGS is to provide a service to support, through GPS data products, geodetic and geophysical research activities. Cognizant of the immense growth in GPS applications the secondary objective of the IGS is to support a broad spectrum of operational activities performed by governmental or selected commercial organizations. The Service also develops the necessary standards/specifications and encourages international adherence to its conventions.

IGS collects, archives and distributes GPS observation data sets of sufficient accuracy to satisfy the objectives of a wide range of applications and experimentation. These data sets are used by the IGS to generate the following data products:

- high accuracy GPS satellite ephemerides
- earth rotation parameters
- coordinates and velocities of the IGS tracking stations
- GPS satellite and tracking station clock information
- ionospheric information
- tropospheric information.

The accuracies of these products are sufficient to support current scientific objectives including:

- realization of global accessibility to and the improvement of the International Terrestrial Reference Frame (ITRF)
- monitoring deformations of the solid earth
- monitoring earth rotation
- monitoring variations in the liquid earth (sea level, ice-sheets, etc.)
- scientific satellite orbit determinations
- ionosphere monitoring
- climatological research, eventually weather prediction.

The IGS accomplishes its mission through the following components:

- networks of tracking stations
- data centers
- Analysis and Associate Analysis Centers
- Analysis Coordinator
- Central Bureau
- Governing Board.

## NETWORKS OF TRACKING STATIONS

IGS Stations provide continuous tracking using high accuracy receivers and have data transmission facilities allowing for a rapid (at least daily) data transmission to the data centers (see below). The stations have to meet requirements which are specified in a separate document. The tracking data of IGS stations are regularly and continuously analysed by at least one IGS Analysis Center or IGS Associate Analysis Center. These analyses must be available to, analysed and published by the ITRF section of the IERS for at least two consecutive years. During this initial period the IGS Central Bureau can temporarily designate new tracking stations as IGS stations.

IGS Stations which are analysed by at least three IGS Analysis Centers for the purpose of orbit generation, where at least one of the Analysis Centers lies on a different continent than the station considered, are in addition called IGS Global Stations.

All IGS stations are qualified as reference stations for regional GPS analyses. The ensemble of the IGS stations forms the IGS network (polyhedron).

## DATA CENTERS

The data centers required fall into three categories: Operational, Regional, and Global Data Centers.

The Operational Data Centers are in direct contact with the tracking sites. Their tasks include suitable data reformatting into a uniform format, compression of data files, maintenance of a local archive of the tracking data in its original receiver and in its reformatted format, and the electronic transmission of data to a Regional or Global Data Center. The Operational Data Center must download data from the receivers located at the Core sites on a timely (e.g., daily) basis, without interruption.

The Regional Data Centers reduce traffic on electronic networks. They collect reformatted tracking data from several Operational Data Centers, maintain a local archive of the data received and transmit these data to the Global Data Centers. Regional Data Centers may also meet the operational requirements (as defined in the above paragraph) of strictly regional network operations.

The Global Data Centers are the main interfaces to the Analysis Centers and the outside user community. Their primary tasks include the following:

- receive/retrieve, archive and provide on line access to tracking data received from the Operational/Regional Data Centers
- provide on-line access to ancillary information, such as site information, occupation histories, etc.,
- receive/retrieve, archive and provide on-line access to IGS products received from the Analysis Centers
- backup and secure IGS data and products.

## ANALYSIS CENTERS

The analysis centers fall into two categories: Analysis Centers and Associate Analysis Centers.

The Analysis Centers receive and process tracking data from one or more data centers for the purpose of producing IGS products. The Analysis Centers are committed to produce daily products, without interruption, and at a specified time lag to meet IGS requirements. The products are delivered to the Global Data Centers and to the IERS (as per bilateral agreements), and to other bodies, using designated standards.

The Analysis Centers provide as a minimum, ephemeris information and earth rotation parameters on a weekly basis, as well as other products, such as coordinates, on a quarterly basis. The Analysis Centers forward their products to the Global Data Centers.

Associate Analysis Centers are organizations that produce unique products, e.g., ionospheric information or Fiducial Station coordinates and velocities within a certain geographic region. Organizations with the desire of becoming Analysis Centers may also be designated as Associate Analysis Centers by the Governing Board until they are ready for full scale operation.

## ANALYSIS COORDINATOR

The Analysis Centers are assisted by the Analysis Coordinator.

The responsibility of the Analysis Coordinator is to monitor the Analysis Centers activities to ensure that the IGS objectives are carried out. Specific expectations include quality control, performance evaluation, and continued development of appropriate analysis standards. The Analysis Coordinator is also responsible for the appropriate combination of the Analysis Centers products into a single set of products. As a minimum a single IGS ephemeris for each GPS satellite is to be produced. In addition, IERS will produce ITRF station coordinates/velocities and earth rotation parameters to be used with the IGS orbits.

The Analysis Coordinator is to fully interact with the Central Bureau and the IERS. Generally the responsibilities for the Analysis Coordinator shall rotate between the Analysis Centers with appointments and terms specified by the Governing Board.

## CENTRAL BUREAU

The Central Bureau (CB) is responsible for the general management of the IGS consistent with the directives and policies set by the Governing Board. The primary functions of the CB are to facilitate communications, coordinate IGS activities, establish and promote compliance to IGS network standards, monitor network operations and quality assurance of data, maintain documentation, and organize reports, meetings and workshops, and ensure the compatibility of IGS and IERS by continuous interfacing with the IERS. To accomplish these tasks the CB fully interacts with the independent Analysis Coordinator described above.

Although the Chairperson of the Governing Board is the official representative of the IGS at external organizations, the CB, consonant with the directives established by the Governing Board, is responsible for the day-to-day liaison with such organizations.

Through the existing reciprocity agreement between IGS and IERS the CB serves as the GPS Coordinating Center for IERS, and as such its designated representative, subject to Governing Board approval, is a member of the IERS Directing Board. Such a representative will become a non-voting member of the Governing Board. In turn, the IERS Directing Board designates a representative to the IGS Governing Board. This arrangement is to assure full cooperation between the two services.

The CB coordinates and publishes all documents required for the satisfactory planning and operation of the Service, including standards/specifications regarding the performance, functionality and configuration requirements of all elements of the Service including user interface functions.

The CB operates the communication center for the IGS. It maintains a hierarchy of documents and reports, both hard copy and electronic, including network information, standards, newsletters, electronic bulletin board, directories, summaries of IGS performance and products, and an Annual Report.

In summary, the Central Bureau performs primarily a long term coordination and communication role to ensure that IGS participants contribute to the Service in a consistent and continuous manner and adhere to IGS standards.

## GOVERNING BOARD

The Governing Board (GB) consists of fifteen members. They are distributed as follows:

Elected by IGS Associates (see below):	3
Analysis Centers' representatives	1
Data centers' representative	2
Networks' representatives	
Elected by the Governing Board upon recommendations	
from the Central Bureau, for the next term:	
Representatives of Analysis, Data Centers or Networks	2
Members at large	2
Appointed members:	
Director of the Central Bureau	1
Representative of the IERS	1
IGS representative to the IERS	1
IAG/FAGS representative	1
President of IAG Sect. II or Com.VIII (CSTG)	1
Total	15

The appointed members are considered ex officio and are not subject to institutional restrictions. The other ten persons must be members of different organizations and are nominated for each position by the IGS components they represent as listed above (six persons) , or by the Central Bureau (four persons) for a staggered four year term renewable once. The GB membership should be properly balanced with regard to supporting organizations as well as to geography.

The election for each position is by the number of nominations received from the relevant IGS component, i.e., from the networks (for this purpose organizations operating two or more Global Stations are considered a network), from the Analysis Centers and from the Data Centers. In case of a tie, the election is by the members of the Governing Board and the IGS Associate Members (see below) by a simple majority of votes received. The election will be conducted by a nominating committee of three members, the chair of which will be appointed by the Chair of the IGS Governing Board.

The Chairperson is one of the members of the GB elected by the Board for a term of four years with the possibility of reelection for one additional term. The Chairperson does not vote, except in case of a tie. He/she is the official representative of IGS to external organizations.

The IAG / FAGS representative is appointed by the IAG Bureau (or by FAGS) for a maximum of two four-year terms. Members of the GB become IAG Fellows with the appropriate rights and privileges after an initial two- year period.

The GB exercises general control over the activities of the Service including modifications to the organization that would be appropriate to maintain efficiency and reliability, while taking full advantage of the advances in technology and theory.

Most GB decisions are to be made by consensus or by a simple majority vote of the members present, provided that there is a quorum consisting of at least ten

members of the GB. In case of lack of a quorum the voting is by mail. Changes in Terms of and Chairperson of the GB can be made by a 2/3 majority of the members of the GB, i.e., by ten or more votes.

The secretariat of the GB is provided by the Central Bureau.

The Board shall meet at least annually and at such other times as shall be considered appropriate by the Chairperson or at the request of five members.

#### IGS ASSOCIATE MEMBERS

Persons representing organizations which participate in any of the IGS components and who are not members of the Governing Board are considered IGS Associate Members. They are generally invited to attend nonexecutive sessions of the GB meetings with voice but without vote.

IGS Associate Members together with the GB vote for the incoming members of the GB every two years, unless the membership has already been determined on the basis of the number of nominations received for each vacant position as described above.

IGS Associate Members are considered IAG Affiliates with the appropriate rights and privileges.

#### IGS CORRESPONDENTS

IGS Correspondents are persons on a mailing list maintained by the Central Bureau, who do not actively participate in the IGS but express interest in receiving IGS publications, wish to participate in workshops or scientific meetings organized by the IGS, or generally are interested in IGS activities. Ex officio IGS Correspondents are the following persons:

- IAG General Secretary
- President of IAG Section II or of Commission VIII
- President of IAG Section V

2 January 1996 (IIM)



SYSTEM



# IGS CENTRAL BUREAU INFORMATION SYSTEM

## International GPS Service for Geodynamics

IGSCB.DIR README.TXT TREE.TXT			complete file list general information directory structure
center	analysis	'center'.acn	Analysis Center descriptions
	data	'center'.dcn	Data Center descriptions
	oper	'center'.ocn	Operational Center descriptions
data	format	rinex2.txt	RINEX format specification
		sinex.txt	SINEX format specification
		sp3.txt	SP3 orbit format specification
	holding	'center'.syn 'center'.s'yy' glob'mmyy'.syn glob'yyyy'.syn	Data Center holdings Data Center holdings by year data availability by month data availability by year IGS data network diagram
general	network	igs.net	
	glonass	constell.glo nagu'yyyy'.mes nagu'yyyy'.sub	GLONASS constellation status NAGU messages by year NAGU subject index by year
			NANU GPS constellation status EUREF Information System info
	gps	constell.gps euref.txt nanu'yyyy'.mes nanu'yyyy'.sub sources.txt status.zim	NANU messages by year NANU subject index by year GPS information sources ZIMM current tracking status
mail	org	meetings.agu meetings.iag	AGU symposia/meetings IAG symposia/meetings
	address	cddis.adr directory.txt dose.adr igsmail.adr igsreport.adr scign.adr	CDDIS SGP address catalog IGS Colleague Directory text DOSE Mail distribution list IGS Mail distribution list IGS Report distribution list SCIGN Mail distribution list
		igsmail	IGSMESS.INDEX igsmess.'nnn'
		igsreport	IGSREPORT.INDEX igsreport.'nnn'
	regional	DOSE SCIGN	IGS Reports DOSE Mail archive SCIGN Mail archive
product	'www'	igr'wwwwd'.erp.sp3.sum igs'wwwwd'.erp.sp3.sum	Final Orbit Combination Rapid Orbit Combination
	holding	'center'.prd	Analysis Center product holdings
	iers	bulletinb.'nn' eop90c04.'yy'	IERS earth orientation IERS earth rotation parameters
	prelim	igp'wwwwd'.erp.sp3.sum	IGS preliminary combined orbit
resource		g_board.txt igsmap'yymm'.ps newstation.log newstation.txt terms.txt	IGS Governing Board Tracking Network (PostScript) new station log form new station checklist IGS Terms of Reference
software	cbis	dos unix vms	CBIS browsing/ftp program
	compress	dos vms	compression/decompression programs
	qc	aux dos unix vms	quality check program for GPS data
station	coord	itrfrf'yy'.ssc	ITRF92 station coordinates
	general	antenna.gra	antenna diagrams
		igs_ol.pcv	antenna phase center variations
		rcvr_ant.tab	receiver/antenna table
	log	'site'mmyy'.log	station logs
	oldlog	'site'mmyy'.log	old station logs
tie	localtie	localtie.chg	local tie changes/updates
		localtie.tab	local tie file

ftp://igsb.jpl.nasa.gov/igsb  
ftp://schubert.ign.fr/pub/igsb

http://igsb.jpl.nasa.gov



# The International GPS Service for Geodynamics – Benefits to Users

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Institute of Navigation  
ION GPS-94  
7th International Technical Meeting  
Salt Lake City, Utah  
September 20–23, 1994

## BIOGRAPHIES

*James F. Zumberge* serves the International GPS Service for Geodynamics (IGS) both as a member of its Central Bureau, as well as a member of one of seven IGS Analysis Centers. He received his Ph.D. in physics from the California Institute of Technology in 1981, and worked on industrial applications of nuclear physics at MDH Industries in Monrovia, CA, before joining the Space Geodesy and Geodynamics Systems Group at Caltech's Jet Propulsion Laboratory (JPL) in 1990.

*Ruth E. Neilan* is the Director of the IGS Central Bureau, funded by NASA at JPL in Pasadena, CA. She received her M.S. in Civil and Environmental Engineering from the University of Wisconsin–Madison in 1986 and has been involved in the coordination and establishment of the GPS Global Network since 1987. During the period 1987 until 1993 she was the Project Manager for regional GPS investigations funded by NASA's Geodynamics Program.

*Gerhard Beutler* currently is the chairman of the IGS. He received his Ph.D. in astronomy from the University of Berne, Switzerland. Subsequently he worked on several projects in fundamental astronomy. The development of algorithms to process observations of the GPS eventually led to the development of the Bernese GPS Software Package and to the operation of the CODE processing center of the IGS.

*Werner Gurtner* was a member of the IGS Oversight Committee, helped organize the data flow within the IGS network, and developed the IGS Central Bureau Information System. He received his Ph.D. in technical sciences from the Federal Institute of Technology in Zurich, Switzerland in 1978. He is a researcher at the Astronomical Institute of the University of Berne,

Switzerland, station manager of the institute's observatory and one of the authors of the Bernese GPS Software.

## ABSTRACT

The International GPS Service for Geodynamics is an international scientific service which began formal operation at the beginning of 1994, following several years of planning [1] and a 1½-year pilot service. The IGS collects, archives, and distributes GPS observation data sets, and uses these to generate high accuracy GPS satellite ephemerides, earth rotation parameters, coordinates and velocities of the IGS tracking stations, GPS satellite and tracking station clock information, and ionospheric information.

To accomplish its mission, the IGS consists of a network of GPS tracking stations, Data Centers, Analysis Centers, an Analysis Coordinator, a Central Bureau, and a Governing Board. The accuracies of IGS products are sufficient to support current scientific objectives, including the realization of the International Terrestrial Reference Frame (ITRF), monitoring of the earth's rotation and deformation of its liquid and solid components, ionospheric monitoring, and scientific satellite orbit determination. A Central Bureau Information System (CBIS) allows public access to IGS products, which include precise GPS ephemerides within 2-3 weeks of real time. IGS contributors and customers communicate through electronic mail, and exchanges are archived for future reference.

## INTRODUCTION

The primary objective of the International GPS Service for Geodynamics is to provide a service to support, through GPS data products, geodetic and geophysical research activities. Cognizant of the immense growth in GPS applications the secondary objective of the

IGS is to support a broad spectrum of operational activities performed by governmental or selected commercial organizations. The service also develops the necessary standards/specifications and encourages international adherence to its conventions.

A proof of concept for the International GPS Service for Geodynamics was conducted with a three-month campaign during June–September 1992 [2], and was continued through a pilot service until the formal establishment of the IGS in 1993 by the International Association of Geodesy (IAG). The routine IGS started on January 1, 1994. IGS operates in close cooperation with the International Earth Rotation Service (IERS). The *IGS Terms of Reference* [3] describes in broad terms the goals and organization of the IGS.

The IGS collects, archives, and distributes GPS observation data sets of sufficient accuracy to satisfy the objectives of a wide range of applications and experimentation. These data sets are used by the IGS to generate data products, including high accuracy GPS satellite ephemerides, earth rotation parameters, coordinates and velocities of the IGS tracking stations, GPS satellite and tracking station clock information, and ionospheric information.

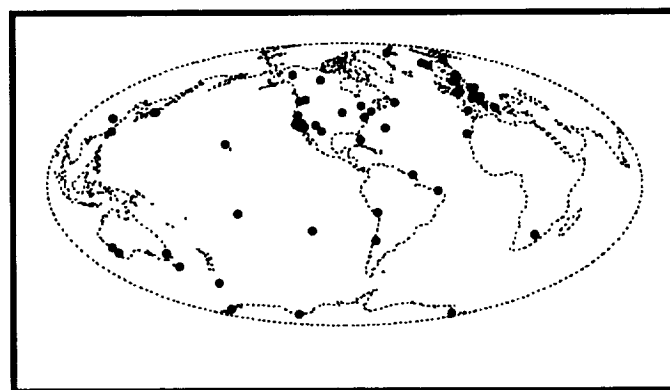
In particular the accuracies of these products are sufficient for the improvement and extension of the International Terrestrial Reference Frame (ITRF), the monitoring of solid earth deformations, the monitoring of earth rotation and variations in the liquid earth (sea level, ice-sheets, etc.), for scientific satellite orbit determinations, and ionosphere monitoring.

To accomplish its mission, the IGS consists of a network of GPS tracking stations, several Data Centers, Analysis Centers, an Analysis Coordinator, a Central Bureau, and a Governing Board.

## OPERATION OF THE IGS

Shown in Figure 1 is the distribution of sites that comprise the IGS global network of GPS tracking receivers. Within the next few years, expansion of the global network will address the paucity of sites near longitude 90°E, with planned coverage in Central Asia and islands in the Indian Ocean.

Each site has a high-precision dual-frequency P-code receiver which records measurements at 30-sec intervals. IGS Operational Data Centers (Table 1) are in direct contact with the tracking sites, and are responsible for fetching raw receiver data, formatting it in a common



**Figure 1 Network of IGS Tracking Stations, as of September 1, 1994**

standard [4], and forwarding the data to Regional or Global Data Centers.

Reformatted tracking data from several Operational Data Centers are collected at Regional Data Centers. A local archive of the data received is maintained, and the data are transmitted to the Global Data Centers. Regional Data Centers thus serve to reduce traffic on electronic networks.

**TABLE 1. IGS DATA CENTERS**

<b>Operational &amp; Regional</b>	
National Oceanic and Atmospheric Administration	US
Institut für Angewandte Geodäsie	Germany
Natural Resources, Canada	Canada
Norwegian Mapping Authority	Norway
Jet Propulsion Laboratory	US
.....	
<b>Global</b>	
NASA/Goddard Space Flight Center	US
Institut Géographique National	France
Scripps Institution of Oceanography	US

The Global Data Centers serve as interfaces to the Analysis Centers and the external user community. Their purpose is to receive/retrieve, archive, and provide on-line access to tracking data. In addition, Global Data Centers provide access to Analysis Center products.

There are currently seven IGS Analysis Centers (AC's) (Table 2) – three in the US, one in Canada, three in Europe – that routinely analyze some subset of the data

from the IGS global network. AC's compute precise GPS ephemerides and earth orientation parameters. Daily results are posted periodically, typically once each week.

The IGS Analysis Coordinator – Jan Kouba at Natural Resources, Canada – is responsible for producing a single IGS orbit, based on the combination of orbits from the separate AC's [5]. Because of consistency checks, the combined orbit is largely free of some systematic errors that occasionally remain in results from individual AC's. Agreement among AC's in GPS satellite ephemerides is generally at the level of 10 to 30 cm. It is estimated that the absolute accuracy of the IGS orbits is at least one order of magnitude better than the broadcast ephemeris, even when anti-spoofing is in effect.

**TABLE 2. IGS ANALYSIS CENTERS**

Astronomical Institute–University of Berne	Switzerland
European Space Agency	Germany
GeoForschungsZentrum	Germany
Jet Propulsion Laboratory	US
National Oceanic and Atmospheric Administration	US
Natural Resources, Canada	Canada
Scripps Institution of Oceanography	US

Estimates of earth orientation and station coordinates from the AC's are coordinated with the IERS [6]. Through the IGS, GPS-derived station locations are contributing more and more to the ITRF. Over the next few years, a major goal of the IGS will be to include in the ITRF the coordinates of a number of sites that comprise dense regional GPS networks.

Table 3 summarizes the approximate accuracies of IGS orbits, clocks, earth orientation, and station locations ([6], [7], [8]).

## CENTRAL BUREAU INFORMATION SYSTEM

The Central Bureau Information System (CBIS) provides public access to products of the IGS, and also provides a means of electronic messaging among IGS participants. The system, developed in late 1993 by Werner Gurtner, runs automatically.

The CBIS is a client on the Internet's World Wide Web, allowing access with user-friendly Mosaic and Lynx interfaces. For example, on most Unix systems, the command

**TABLE 3. APPROXIMATE ACCURACIES OF IGS PRODUCTS**

GPS ephemerides	10 – 30 cm
GPS clocks	0.5 – 5 nsec
earth orientation – pole	0.2 – 0.7 mas
earth orientation – length of day	0.1 – 0.5 ms/day
station coordinates (annual solutions)	3 mm – 3 cm

lynx <http://igscb.jpl.nasa.gov/>

will connect the user to the CBIS. For those with X-window terminals, `xmosaic` for Unix systems, or the equivalent Macintosh or Windows application, allows a graphical interface to the CBIS.

At the top level of the CBIS one views the following:

The Central Bureau, funded by NASA at Caltech's **Jet Propulsion** Laboratory, supports an Information Service:

- \* **IGS Mail**: An archive of exchanges among IGS participants.
- \* **IGS Reports**: An archive of reports from IGS Data and Analysis Centers.
- \* **Regional Mail**: An archive of exchanges among those interested in specific regional GPS networks.

These collections, with other data, are also available through **anonymous FTP**.

Categories in bold can be selected for further exploration. By sending a message to [igscb@igscb.jpl.nasa.gov](mailto:igscb@igscb.jpl.nasa.gov), you can request that your Internet e-mail address be added to one or more of the mail and report distribution lists. The **anonymous FTP** category is explained in more detail in Table 4, where top-level files and directories are given.

## BENEFITS TO USERS

The IGS has been in formal operation for less than a year, and detailed analysis strategies that exploit the qualities of its data and products are still being developed.

High quality Rinex tracking data from the global tracking network, GPS ephemerides that are more accurate than the broadcast orbits by at least an order of

magnitude, and precisely-determined locations of dozens (and eventually hundreds or more) of sites distributed over the entire globe, all provide benefits to users.

**TABLE 4. TOP-LEVEL OF CBIS ANONYMOUS FTP AREA**

files:	IGSCB.DIR NEWS.TXT README.TXT TREE.TXT
center	contains information on the various IGS Centers (Analysis, Data, etc.)
data	indicates where – at which Data Centers – Rinex data reside
general	miscellaneous information on GPS, IAG, and IGS, including the IGS Terms of Reference
mail	contains indices of mail messages, and the messages themselves
product	contains Analysis Center products: precise ephemerides, earth orientation, weekly summaries
software	contains source code for CBIS-exploring utilities
station	contains information on IGS stations

Geodynamics investigators who use GPS in local regions can include data from one or more nearby IGS stations, fix the site coordinates from such stations to their ITRF values, and fix GPS satellite positions to their IGS-determined values. By doing so the investigator can reduce data from his own network with maximum accuracy and minimum computational burden. Furthermore, the results will be in a well-defined global reference frame.

For more information contact

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## ACKNOWLEDGMENTS

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- [2] Beutler, Gerhard, 1993, The 1992 IGS Test Campaign, Epoch '92, and the IGS Pilot Service: An Overview, in *Proceedings of the 1993 IGS Workshop*, G. Beutler, E. Brockmann, editors, March 25-26, 1993, Bern, Switzerland, pp. 3-9.
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- [6] Feissel, M., and N. Essaïfi, editors, *1993 IERS Annual Report*, July, 1994; Central Bureau of IERS, Observatoire de Paris; 61, avenue de l'Observatoire; F-75014; Paris, France.
- [7] Jan Kouba, editor, *Proceedings of the IGS Analysis Centre Workshop*, October 12-14, 1993, Ottawa, Canada.
- [8] Blewitt, Geoffrey, *Advances in Global Positioning System Technology for Geodynamics Investigations: 1978–1992*, in *Contributions of Space Geodesy to Geodynamics: Technology*, David E. Smith, Donald L. Turcotte, Editors, Geodynamics Series volume 25, American Geophysical Union, Washington, D.C.



# CONTACT SHEETS

## International GPS Service for Geodynamics

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IGS Mail and Central Bureau Information System:

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FAX (818) 393-4965  
Internet: [igsb@igsb.jpl.nasa.gov](mailto:igsb@igsb.jpl.nasa.gov)

The IGS Central Bureau Information System (CBIS), accessible via Internet, provides necessary information to both IGS contributors and the public organizations and individuals who use IGS orbits and tracking data. Summarized global data holdings are updated daily in the information system, indicating the source and dates of observations and how to access them. Also available are IGS products, including accurate and highly reliable IGS GPS orbits, earth rotation parameters, tracking station coordinates and velocities, and satellite and receiver clock information.

The CBIS is accessible through anonymous ftp at:

[igsb.jpl.nasa.gov](ftp://igsb.jpl.nasa.gov) (Internet address 128.149.70.171)  
in the directory /igsb. The files README.TXT, TREE.TXT and IGSCB.DIR in the main directory provide online help and current directory and file information. For World Wide Web users, the required URL is:

**<http://igsb.jpl.nasa.gov/>**

Hypermedia client programs like Lynx and NCSA Mosaic are freely available and allow for easy navigation and file retrieval.

Requests to be included in the IGS Mail service, or questions regarding IGS Mail, the CBIS or any aspect of the IGS can be directed to:  
[igsb@igsb.jpl.nasa.gov](mailto:igsb@igsb.jpl.nasa.gov)

### ANALYSIS CENTER COORDINATOR

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The official IGS orbits are produced by forming a weighted combination of the ephemerides submitted by each individual analysis center. Each week the Analysis Center Coordinator provides the precise orbits and clocks, and a summary report file documenting the combination process. The resulting ephemerides and clocks are output to daily files in the SP3 format and these product files can be obtained from the CBIS or any of the Global Data Centers. For more details on the orbit combination and complete references for the software see:

Beutler G., J. Kouba, T. Springer,  
1993, 'Combining Orbits of the IGS  
Processing Centres', in Proceedings of  
IGS Analysis Centre Workshop,  
October 12-14, Ottawa, pp 19-55.  
(available through the Central Bureau).

### ANALYSIS CENTERS

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## **ANALYSIS CENTERS (CON'T.)**

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